

1 AN INTERNAL COMBUSTION ENGINE MACHINE
2 HAVING IMPROVED POWER, EFFICIENCY AND EMISSIONS

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Title of the Invention

An internal combustion engine machine incorporating significant improvements in power, efficiency and emissions control

Cross Reference to Related Applications

This application is based on provisional application serial number 60/424,981, filed on November 08, 2002.

Statement Regarding Federally Sponsored Research or Development

Not Applicable

Description of Attached Appendix

Not Applicable

Background of the Invention

This invention relates generally to the field of internal combustion engines and more specifically to an internal combustion engine machine incorporating significant improvements in power, efficiency and emissions control.

This invention was conceived in response to the need for greater simplicity, efficiency and power in internal combustion piston engine designs.

Although two-stroke cycle engine technology has many advantages, it has deficiencies have caused widespread legislative restriction on its use and, in the US, an outright EPA ban on it by the year 2006.

Additionally, in nations where sophistication of publicly available technology is low, the prevalent two-cycle technology is producing high levels of air pollution and creating excessive fuel and lubricating oil expense due to the fact that the lubricating oil

1 is burned along with the fuel in inefficient combustion. However, it is the only
2 technology that the users can afford to acquire and maintain. This invention was
3 conceived to defeat these problems.

4 Prior internal combustion piston engine technology has been divided into two
5 primary groups, two-stroke cycle engines and four-stroke cycle engines. Prior two-
6 stroke cycle engine technology has a number of advantages over four-stroke cycle
7 technology. These advantages are a higher power to weight ratio and greater design
8 simplicity that results in low production and maintenance costs. Four-stroke technology,
9 on the other hand retained advantages over two-stroke technology in efficiency,
10 dependability, and clean operation. No prior technology produced the advantages of
11 both types in one engine.

12 13 Two Stroke Engine Technology Prior Art in General

14 Prior two-stroke cycle engines suffer a number of deficiencies. They are
15 inefficient, up to or beyond ten times less efficient than comparable four-stroke cycle
16 engines. They also inconveniently require that oil be measured and mixed with their
17 fuel. As a result, prior two-stroke cycle engines operate much less cleanly than
18 comparable four-stroke cycle engines, produce several times the volume of toxic
19 emissions over that of comparable four-stroke cycle engines, experience a high
20 incidence of plug fouling, are notoriously undependable, and use excessive fuel and
21 lubricant.

22 Previous attempts at improved two-stroke technology have included linier engine
23 configurations with pistons in each piston pair located diametrically opposite one
24 another, as does this invention. One such popular configuration is popularly known as
25 the "Bourke" engine. However, such previous linier designs have had a comparably
26 narrow range of RPM speeds within which they could perform. These speeds are

1 unsatisfactory for many applications and also complicate engine performance and
2 design parameters for the various internal components.

3 Prevalent conventional engine technology causes wear on the many moving
4 machine parts, largely due to components of articulated motion. This wear is
5 concentrated, in particular, on the pistons, piston rings, cylinders, wrist pins, connecting
6 rod bearings; main bearings and other related principal parts.

7 In present conventional engine technology, high operating temperatures bring
8 increased complexity and expense in engine design and choice of materials.

9 Present conventional technology is not adaptable to attain significant energy
10 savings by being run on fewer than all cylinders, when full power is not required, letting
11 the unused cylinders and pistons disconnect from the drive train and come to complete
12 rest until again needed.

13 14 Cylinder Head Exhaust Valve Prior Art

15 A number of cam or hydraulically controlled cylinder head exhaust valves are
16 taught in prior two-stroke technology, but none were found teaching cylinder head
17 exhaust valves applied to spark ignited two-stroke technology. However, spark ignition
18 is the more compatible, and therefore overwhelmingly more dominant, configuration for
19 lightweight engines. Therefore, this new use of a cylinder head exhaust valve in
20 application to spark ignited two-stroke technology with the resultant increase in
21 efficiency and reduction in toxic emissions is a much-needed improvement.

22 US patent 2,097,883 to Johansson teaches an exhaust valve for two-stroke cycle
23 diesel engines (i.e., not spark ignited). The valve in that patent is specifically designed
24 to control combustion chamber pressure in compression ignition engines.

1 Oil Hoarding Rings Prior Art

2 No use of rings on a piston for the purpose of sealing the lubricated space and
3 retaining oil between them has been found in prior technology. In fact, US patent
4 4,364,307 teaches against such usage, particularly noting that it would be inappropriate
5 to place sealing rings both above and below a lubrication groove. That, however, is
6 precisely one design characteristic of this invention.

7 Dynamic Pressure Pump, Double-Acting Piston Rod and Multi-Function Pistons to
8 Carry, Distribute, and Recover Lubrication Oil

9 A number of patents teach the transport of lubrication oil via a piston rod and/or
10 pistons adapted to distribute oil transported by such a rod. Some use dynamic energy
11 to propel the oil. (The general principle of dynamic energy/pressure pumps is to apply
12 dynamic energy to the medium, such as oil, by scooping it up and propelling it by rapid
13 cyclical motion.)

14 However, none of said patents provide for complete "round trip" oil circulation via
15 this method. They transport oil only one-way. This necessarily limits utility of the oil in
16 cooling the engine, for it must either be slowly metered out so as to prevent a significant
17 amount of it burning with the normal engine combustion, or it must be restricted from the
18 cylinder interior entirely.

19 Further, dynamical propulsion oil pumps and oil carrying piston rod systems
20 consistently teach their use only in lubricating the piston wrist pins, or lubricating/cooling
21 the bottoms of the pistons. None are designed, as this patent teaches, to provide the
22 primary lubrication to cylinder walls plus a return route for the oil for complete circulation
23 loops. Examples include US patents 2,569,103 and 2,645,213 (to Huber), US patents
24 4,466,387, 4,502,421, and 4,515,110 (Perry), US patent 2,865,349 (MacDonald), US
25 patent 3,633,468 (Burck), US patent 3,992,980 (Ryan et al), and US patent 3,930,472
26 (Athenstaedt), and US patent 2,899,016 (Swayze).

1 Additional examples of systems incorporating piston rod oil transport also include
2 pressure sealed walls at the base of their cylinders, as does this patent application.
3 (These sealed walls are also known as "cross heads.") However, as in those described
4 above, none provide for complete oil circulation cycles to include oil return from the
5 engine cylinder to the sump. Examples of these include US patents 1,268,056
6 (Ruether), 1,827,661 (Kowarick), 2,064,913 (Hedges), 2,244,706 (Irving) and 3,710,767
7 (Smith).

8 9 Brief Summary of the Invention

10 An object of the invention is to provide an improved two-cycle reciprocating
11 internal combustion engine that eliminates the previous disadvantages of two cycle
12 technology as compared to four cycle technology, in that this engine produces higher
13 efficiency, decreased toxic emissions, less fouling, and greater dependability while
14 retaining the advantages of simplicity of production and of maintenance, and high power
15 per unit weight.

16 Still yet another object of the invention is to provide an improved reciprocating
17 internal combustion engine wherein, it is possible to increase the power or torque to
18 weight ratio up to 100 percent or more over that of four-cycle technology without
19 increasing the bore and stroke, compression ratio, or number of cylinders, while at the
20 same time retaining a wide available range of RPMs, particularly including the most
21 desirable or recommended operating engine speeds with special consideration given to
22 friction heat and reciprocal motion, and thereby maintaining the most desirable
23 aspiration conditions and reciprocating valve performance characteristics, resulting in a
24 more efficient fuel consumption rate, over previous conventional or linier two-cycle
25 engines.

1 Another object of the invention is to provide two-cycle engine that, unlike two
2 cycle engines under previous technology, is not subject to the inconvenient necessity of
3 mixing lubricating oil with the fuel in the same tank, nor in the combustion chamber.

4 A further object of the invention is to provide a two-stroke cycle internal
5 combustion engine in which the lubricant circulates and is re-used independently from
6 the fuel, thus using less lubricant.

7 Another object of the invention is to provide a two-cycle engine that, unlike
8 two cycle engines under previous technology, is not subject to the extremely high
9 pollutant emissions that result from the necessity of mixing lubricating oil with the fuel in
10 the combustion chamber.

11 Still yet another object of the invention is to provide a two cycle engine that,
12 unlike two cycle engines under previous technology, is not subject to the
13 undependability and frequent spark plug fouling that results from the necessity of mixing
14 lubricating oil with the fuel in the combustion chamber.

15 Another object of the invention is to provide a simple, compact engine structure
16 that is, aside from the drive train, essentially symmetrical wherein oppositely disposed
17 parts are substantially identical.

18 Yet another object of the invention is to provide an internal combustion engine
19 that is simple and inexpensive to build and maintain.

20 Another object of the invention is to provide an improved reciprocating internal
21 combustion engine wherein the wear caused by friction on piston, piston rings,
22 cylinders, wrist pins, connecting rod bearings; main bearings another principal parts of
23 the engine is significantly reduced below that of in conventional two-cycle or four-cycle
24 engines having the same bore, stroke, compression ratio and number of cylinders
25 through virtually eliminating piston side loads and the resultant piston and cylinder wear.

1 Yet another object of the invention is to produce an improved reciprocating
2 internal combustion engine wherein each cylinder can produce one combustion stroke
3 with each revolution of the crankshaft. This amounts to two power strokes for each
4 piston pair for each shaft revolution and a power stroke for each movement of the piston
5 rod.

6 Another object of the invention is to produce an improved reciprocating internal
7 combustion engine wherein the piston rod travel between combustion strokes is 50
8 percent less than in present conventional two-cycle technology engines of the same
9 bore and stroke, compression ratio, and number of cylinders, thus saving energy
10 wasted in previous technology and saving commensurate fuel.

11 A further object of the invention is to provide an improved internal combustion
12 reciprocating engine that runs significantly cooler than those of present technology, thus
13 reducing corrosion and wear and making choice of applicable construction materials
14 broader and less expensive. The improved cooling is derived from the increased
15 lubricating/cooling oil flow provided and also from expansion cooling of the exhaust
16 gases.

17 Another object of the invention is to provide an improved reciprocating internal
18 combustion engine having increased life expectancy by reducing the need for the
19 engine to labor excessively or to be operated in an R.P.M. speed range that is beyond
20 the design capability originally intended or recommended in order to fulfill the
21 requirements for torque and/or horsepower.

22 Another object of the invention is to provide a linear two-stroke cycle internal
23 combustion engine that operates smoothly and efficiently over a wide range of rpm
24 speeds.

25 Still yet another object of the invention is to provide an improved reciprocating
26 internal combustion engine that is particularly adaptable to being run on fewer than all

1 cylinders when full power is not required, letting unused banks of cylinders and pistons
2 disconnect from the drive train and come to complete rest until again needed, thus
3 saving energy and also ensuring that the load on each end of the piston rod remains
4 substantially equal in that for any given fuel setting the force of the explosion is the
5 same, that is, the unit force exerted upon the opposite ends of the piston rod by
6 successive explosions is equal, even when a pair of pistons is put in "resting" mode.

7 A further object of the invention is to provide an internal combustion engine that
8 can operate using a wide range of fuels to include alcohol, gasoline, diesel, and others.

9 Still yet another object of the invention is to provide an internal combustion
10 engine that is easily adapted for glow plug, spark ignition or compression ignition.

11 Another object of the invention is to provide improved reciprocating internal
12 combustion engine technology compatible to both two-cycle and four-cycle technology
13 of increased simplicity over each or these present technologies.

14 Other objects and advantages of the present invention will become apparent
15 from the following descriptions, taken in connection with the accompanying drawings,
16 wherein, by way of illustration and example, three embodiments of the present invention
17 are disclosed.

18 In accordance with preferred embodiments of the invention, there is disclosed a
19 reciprocating internal combustion engine machine incorporating significant
20 improvements in power, efficiency and emissions control, primarily by eliminating the
21 mix lubricating oil with the engine fuel and segregating the lubricating oil and fuel at all
22 times.

23 24 Brief Description of the Drawings

25 The drawings constitute a part of this specification and include exemplary modes
26 of the invention, which may be embodied in various forms. It is to be understood that in

1 some instances various aspects of the invention may be shown exaggerated or
2 enlarged to facilitate an understanding of the invention.

3
4 Fig. 1 is a perspective view of the engine in the first preferred mode from the
5 back or "cam drive" side.

6 Fig. 2 is a perspective view of the engine in the first preferred mode from the
7 front or "output shaft" side.

8 Fig. 3 is a cutaway view of the engine in the first preferred mode from the front or
9 "output shaft" side.

10 Fig. 3A is a cutaway view of the engine in the second preferred mode from the
11 front or "output shaft" side.

12 Fig. 3B is an expanded cutaway view of a section of the engine as illustrated in
13 Fig. 3A.

14 Fig. 3C is a perspective three quarter view with phantom images of the cylinder
15 interior of the engine in the second preferred mode.

16 Fig. 3D is a perspective three quarter view of the engine in the second preferred
17 mode.

18 Fig. 4 is a view of the engine oil sump/crankcase, configured for the first or
19 second preferred modes, from the top with the top-plate removed, providing a view of
20 the gears.

21 Fig. 5 is a cutaway view of the engine sump/crankcase, configured for the first or
22 second preferred modes, from the back or "cam drive" side.

23 Fig. 6 is a partial cutaway side view of the multi-function piston configured for the
24 first or second preferred modes.

25 Fig. 7 is a top cutaway view of the multi-function piston configured for the first or
26 second preferred modes.

Fig. 8 is a bottom cutaway view of the multi-function piston configured for the first or second preferred modes.

Fig. 9 is a cut-away view of a portion of the engine incorporating a "pop-top" multi-function piston as used in the third preferred mode.

Fig. 10 is a side view of a "pop-top" multi-function piston having an air/fuel intake valve in its head, as used in the third preferred mode, with the valve in the open position.

Fig. 11 is a side view of a "pop-top" multi-function piston of the third preferred mode as in Fig. 10, but with the air or air/fuel intake valve in the closed position.

Fig. 12 is a top view of the "pop-top" multi-function piston used in the third preferred mode as represented in Figs. 10 and 11.

Fig. 12a is an expanded top view of the center section of the multi-function "pop-top" piston illustrated in Fig. 12.

Fig. 13 is a perspective view of the engine in a single cylinder configuration, aspirated and lubricated after the manner of the first preferred mode.

Lists of Numbered Components for Each Figure

FIG. 1

100	engine
101	oil sump/crank case
101a	oil sump/crank case top and top plate
101b	oil sump/crank case combination end walls/cylinder compression walls
101c	oil sump/crank case side walls
101d	oil sump/crank case bottom
102	air/fuel intake manifold

1	102a	carburetor
2	102b	fuel inlet
3	102c	throttle cable
4	102d	carburetor air intake
5	102e	one-way air intake reed valve housing
6	103	cylinder
7	103a	cylinder sidewall
8	104	cylinder head
9	105	exhaust assembly block
10	106	exhaust cam block
11	107	exhaust port to atmosphere
12	108	exhaust cam passive sprocket
13	109	exhaust cam power sprocket
14	110	exhaust cam drive belt
15	111	exhaust cam belt tension pulley
16	112	output drive shaft
17	113	spark-plug
18	114	spark-plug wires
19	115	air/fuel transfer passage cover

20

21 **FIG. 2**

22	105	exhaust assembly block
23	106	exhaust cam block

1	114	spark-plug wires
2	201	combination fly-wheel/starter cog
3	202	starter motor (engaged)
4	206	exhaust valve cam
5	207	magneto pick-ups

6

7 FIG. 3

8	101	oil sump/crank case
9	101b	oil sump/crank case combination end walls/cylinder compression walls
10	103	piston cylinder
11	103a	cylinder side wall
12	104	cylinder head
13	107	exhaust port to atmosphere
14	112	output drive shaft
15	113	spark-plugs
16	115	air/fuel transfer passage cover
17	301	oil
18	302	sump oil pick-up pipe
19	302a	sump oil pick-up pipe nozzle
20	303	sump oil return outlet pipe
21	303a	piston rod sump outlet port
22	304	piston rod
23	305	push rod

1	306	crank plate
2	306a	cam drive shaft
3	307	output drive shaft cog
4	308	multi-function piston
5	308a	piston oil inlet ports
6	308b	piston oil outlet ports
7	308c	oil hoarding rings
8	308d	piston head
9	308e	piston base
10	309	air/fuel transfer passage
11	311	exhaust valve
12	312	exhaust valve stem
13	313	exhaust valve stem ball
14	314	exhaust valve spring
15	315	exhaust valve cam
16	316	cylinder combustion chamber
17	317	cylinder compression chamber
18	317a	cylinder compression chamber air or air/fuel inlet port
19	317b	cylinder compression chamber air or air/fuel inlet port one-way reed valve
20	317c	cylinder compression chamber air or air/fuel outlet port
21	317d	cylinder combustion chamber air or air/fuel inlet port
22	318	pressure seal
23		

1 FIG 3A

- 2 319 air/fuel transfer passage circular cover
- 3 320 cylinder compression chamber air or air/fuel outlet circle of ports
- 4 321 cylinder combustion chamber air or air/fuel inlet circle of ports

5

6 FIG 3B

- 7 319 air/fuel transfer passage circular cover
- 8 320 cylinder compression chamber air or air/fuel outlet circle of ports
- 9 321 cylinder combustion chamber air or air/fuel inlet circle of ports

10

11 FIG 3C

- 12 319 air/fuel transfer passage circular cover
- 13 320 cylinder compression chamber air or air/fuel outlet circle of ports
- 14 321 cylinder combustion chamber air or air/fuel inlet circle of ports

15

16 FIG 3D

- 17 319 air/fuel transfer passage circular cover

18

19 FIG. 4

- 20 101b oil sump/crank case combination end walls/cylinder compression walls
- 21 112 output drive shaft
- 22 302 sump oil pick-up pipe
- 23 302a output drive shaft

- 1 303 oil return outlet pipe
- 2 304 piston rod
- 3 305 push rod
- 4 306 crank plate
- 5 306a cam drive shaft
- 6 307 output drive shaft cog
- 7 318 pressure seal

8

9 FIG. 5

- 10 101b oil sump/crank case combination end walls/cylinder compression walls
- 11 112 output drive shaft
- 12 301 oil
- 13 302 sump oil pick-up pipe
- 14 302a sump oil pick-up nozzle
- 15 303 oil return outlet pipe
- 16 303a piston rod sump outlet port
- 17 304 piston rod
- 18 305 push rod
- 19 306 crank plate
- 20 306a cam drive shaft
- 21 307 output drive shaft cog
- 22 308 multi-function piston
- 23 318 pressure seal

1

2

3 FIG. 6

4 302 sump oil pick-up pipe

5 303 oil return outlet pipe

6 308a piston oil inlet ports

7 308b piston oil outlet ports

8 308c oil hoarding rings

9 601 piston oil inlet channels

10 602 piston oil outlet channels

11

12 FIG. 7

13 308a piston oil inlet ports

14 601 piston oil inlet port channels

15

16 FIG. 8

17 308b piston oil outlet ports

18 602 piston oil outlet port channels

19

20 FIG. 9

21 103a cylinder side wall

22 900 air or air/fuel intake valve head

23 901 valve seat

1	902	valve stem
2	902a	valve rod
3	902b	control peg
4	903	valve spring
5	903a	valve spring collar
6	904	valve guide
7	905	air or air/fuel valve ports
8	907	piston oil supply port
9	908	piston oil return port
10	911	piston rod
11	950	multi-function piston

12

13 FIG 10

14	900	valve head
15	901	valve seat
16	902	valve stem
17	902a	valve rod
18	903	valve spring
19	903a	valve spring collar
20	904	valve guide
21	905	air or air/fuel valve ports
22	911	piston rod
23	1006	piston oil supply port

1 1008 oil hoarding rings

2 1009 piston head

3 1010 piston base

4

5 FIG. 11

6 900 valve head

7 903 valve spring

8 1107 piston oil return port

9

10 FIG. 12

11 901 valve seat

12 902 valve stem

13 904 valve guide

14 905 air or air/fuel valve ports

15 1006 piston oil supply port

16 1007 piston oil return port

17 1206 piston oil supply channel

18 1207 piston oil return channel

19

20 FIG. 12a

21 902 valve stem

22 904 valve guide

23 911 piston rod

1 1201 sump oil pick-up pipe
2 1202 oil return outlet pipe
3 1203 valve stem oil pinhole
4 1206 piston oil supply channel
5 1207 piston oil return channel

6 FIG 13

7 1301 reciprocating power shaft
8 1302 single, unpaired magneto pick-up

9
10 Detailed Description of the Preferred Embodiments

11 The key novelties of this invention lie in its means of lubrication combined with its
12 means of aspiration and exhaust. A number of alternative modes are offered and they
13 can be “mixed and matched” as needs dictate. Note that in every mode described, fuel
14 injection may be substituted for carburetion, providing increased performance, but at the
15 expense of increased system complexity and monetary cost.

16 Referring to FIG. 1, the engine in the first preferred mode, a two-stroke cycle
17 dynamic pressure powered lubrication configuration (100), has a combination oil
18 sump/crankcase (101) with a top and top plate (101a) and combination end
19 walls/cylinder compression walls (101b), side-walls (101c) and a bottom (101d). It
20 includes an air/fuel intake manifold (102), a carburetor (102a), a fuel inlet (102b), a
21 throttle cable (102c), a carburetor air intake (102d) and a one-way air intake reed valve
22 (102e).

1 On either end of the combination oil sump/crankcase is a cylinder (103) with a
2 sidewall (103a), cylinder head (104), exhaust assembly block (105) exhaust cam block
3 (106) having an exhaust port to atmosphere (107), an air or air/fuel transfer cover (115)
4 and an exhaust cam passive sprocket (108). On each cylinder head is also mounted an
5 air/fuel transfer passage cover and a spark plug (113) with spark plug wire (114)
6 attached.

7 Extending from the facing side wall of the oil sump/crankcase is an output drive
8 shaft (112), a shaft with exhaust cam power sprockets (109) linked to exhaust cam
9 passive sprockets (108) by two exhaust cam drive belts (110), tensioned by an exhaust
10 cam drive belt tensioning pulley (111).

11 Referring to FIG. 2, viewing the engine of FIG. 1 from the opposite side, now
12 additionally detailed are the exhaust assembly block (105), the exhaust cam block
13 (106), the combination flywheel/starter cog (201), the starter motor, shown engaged for
14 starting (202), the exhaust valve cam (206) and the magneto pick-ups (207) connected
15 to the spark plug wires (114).

16 Referring to FIG. 3, which is a partial cut-away view with multi-function pistons
17 intact, one may observe a number of the features that provide a cleaner, more efficient,
18 more dependable, more powerful and more conveniently operated system than extant in
19 prior technology.

20 Keys to this invention are the features that allow engine oil and fuel to remain
21 separate throughout the combustion process. Prior conventional two-cycle engine
22 designs required lubricating oil to be measured and mixed with their fuel. This caused
23 the engines to "burn dirty," producing prodigious levels of toxic emissions, low

1 efficiency, and poor dependability due to constant plug and system fouling. This
2 invention overcomes such problems by incorporating improved aspiration systems and
3 oil circulation systems that allow lubrication while segregating the lubricant from fuel and
4 combustion.

5 One preferred mode, employing (as all preferred modes do) a dynamic pressure
6 lubrication pump system, is illustrated in FIG. 3. Each cylinder (103) has a side-wall
7 (103a), oil sump/crank case combination end walls/cylinder compression wall (101b)
8 that segregates compression chamber (317) fuel and/or air from oil (301) in the crank
9 case/sump (101). This wall is an important key to keeping oil out of the combustion
10 chamber (316). In conventional technology, this wall is absent, leaving the cylinder
11 open to the crankcase. This wall (101b) and its pressure seal (318) also serve as a
12 guide to the piston rod (304) that keeps the rod traveling in strictly linear motion,
13 reducing cylinder wear.

14 In this configuration, oil (301) is picked up by nozzles (302a) of pick-up pipes
15 (302) extending from the piston rod (304) into the crank case/sump (101). These
16 nozzles are thrust to and fro in a reciprocating manner through the sump oil (301) due to
17 the motion of the piston rod (304) to which they are attached. On each thrust, oil is
18 forced into one or the other nozzle by dynamic pressure. The nozzles may be flared in
19 order to increase the dynamic pressure applied. Oil passes through the nozzle, enters
20 the sump oil pick-up pipe (302), via which it then travels to the multi-function piston
21 (308) where it exits via the piston oil inlet ports (308a) and circulates about the multi-
22 function piston (308) between the oil hoarding rings (308c) that prevent the oil (301)
23 from coming in contact with combustion fuel and air or combustion products above or

1 below the multi-function piston (308). As it circulates, continued static pressure from
2 additional oil feed, plus dynamic pressure caused by reciprocating piston rod motion
3 causes the oil to re-enter the multi-function piston (308) through the piston outlet ports
4 (308b) from whence it travels back down the piston rod (304) via an oil return outlet pipe
5 (303) to drip through the piston rod sump outlet (303a) back into the crank case/sump
6 (101) where it cools. Thus, lubricating oil circulation is completed without the oil ever
7 coming into contact with combustion fuel or air.

8 The oil (301) rests in the sump (101) where its cooling is promoted through
9 stirring by motion of the sump oil pick-up pipe (302) until it again enters the circulation
10 system.

11 This diagram illustrates means by which engine performance is further enhanced
12 through the addition of an exhaust valve (311) in each cylinder head (104). Note that
13 each cylinder (103) has an intake port (317d) that resembles and functions in much the
14 same manner those in present popular two-cycle engines. However, the exhaust valve
15 (311) in the cylinder head (104) replaces the standard prior technology exhaust port on
16 the cylinder side-wall. Action of this valve may be independently adjusted in such a way
17 as to obtain maximum scavenging effect, best combustion and best compression time
18 and pressure, allowing the engine to burn more cleanly and making the engine more
19 readily compatible with a wider range of fuels than in previous conventional technology.

20 Further detailed in FIG. 3, are the oil sump/crank case (101), oil in the sump
21 (301), sump oil pick-up pipes (302), sump oil pick-up nozzles (302a), oil return outlet
22 pipes (303) and piston rod oil return outlet ports (303a).

1 A piston rod (304) is linked by a push rod (305) to a crank plate (306) that turns a
2 cam drive shaft (306a) and meshes with an output shaft cog (307) driving an output
3 drive shaft (112). Oil (301) contained in the oil sump/crank case splashes as the
4 various contained components move, thus ensuring complete lubrication of all parts
5 encased therein.

6 Connected to each end of the piston rod is a multi-function piston (308) having
7 piston oil inlet ports (308a), piston oil outlet ports (308b), oil hoarding rings (308c), a
8 piston head (308d), and a piston base (308e).

9 Each cylinder (103) has a head (104) with an exhaust valve (311), exhaust valve
10 stem (312), exhaust valve stem ball (313), exhaust valve spring (314), and exhaust
11 valve cam (315), exhaust ports to atmosphere (107), and spark plugs (113).

12 Each cylinder has a combustion chamber (316), a compression chamber (317),
13 compression chamber air or air/fuel inlet port (317a), compression chamber air or
14 air/fuel inlet port one way reed valve (317b), compression chamber air or air/fuel outlet
15 port (317c), combustion chamber air or air/fuel inlet port (317d), an air or air/fuel
16 transfer passage (309) leading from the compression chamber to the combustion
17 chamber including an air/fuel transfer passage cover (115). At the base of each
18 cylinder is a pressure seal (318) in the oil sump/crankcase combination end walls and
19 cylinder compression walls (101b), through which the piston rod (304) passes.

20 FIG. 3A illustrates an alternative preferred mode with respect to the air or air/fuel
21 transfer passage ports. Instead of equipping each cylinder with a small, elongated air
22 or air/fuel transfer passage and cover with ports into the cylinder at either end (as
23 described in the previously presented mode) this mode substitutes a donut shaped,

1 circular cover (319) that surrounds the cylinder. Under this cover, the cylinder is circled
2 at either end by a ring of outlet ports (320), and inlet ports (321) to facilitate high
3 volume, evenly distributed air flow.

4 FIG. 3B is an enlarged image of a portion of FIG. 3A showing the donut shaped,
5 circular cover (319) that surrounds the cylinder, and the cylinder circled at either end by
6 a ring of outlet ports (320) and inlet ports (321).

7 FIG. 3C further illustrates the features exhibited in FIG. 3B, pointing out the donut
8 shaped, circular cover (319) that surrounds the cylinder and the cylinder circled at either
9 end by a ring of outlet ports (320), and inlet ports (321).

10 FIG. 3D shows the entire exterior arrangement of the engine employing the donut
11 shaped, circular cover (319) that surrounds the cylinder.

12 Now referring to FIG. 4, further detailed for an engine configured in the first or
13 second preferred modes are the combination end walls/cylinder compression walls
14 (101b), the sump oil pick up pipe (302), the sump oil pick-up pipe nozzle (302a), oil
15 return pipe (303), piston rod (304), push rod (305), crank plate (306), cam drive shaft
16 (306a), output drive shaft cog (307), output drive shaft (112) and pressure seal (318).

17 Turning to FIG. 5, expanding on the view in FIG. 4, we can see the combination
18 end walls/cylinder compression walls (101b), the oil (301), the sump oil pick up pipe
19 (302), the sump oil pick-up pipe nozzle (302a), oil return pipe (303), piston rod sump oil
20 outlet port (303a), piston rod (304), push rod (305), crank plate (306), cam drive shaft
21 (306a), output shaft cog (307), output drive shaft (112), the multi-function piston (308)
22 and pressure seals (318).

1 FIG. 6 presents closer detail of the multi-function piston as configured for the first
2 preferred lubrication mode, showing the sump oil pick-up pipe (302), the oil return outlet
3 pipe (303), the piston oil inlet ports (308a), the piston oil outlet ports (308b), the oil
4 hoarding rings (308c), the piston oil inlet channels (601), and the piston oil outlet
5 channels (602).

6 FIG. 7, a cut-away view, further details the multi-function piston shown in FIG. 6
7 showing the piston oil inlet ports (308a) and the piston oil inlet channels (601).

8 FIG. 8, a cut-away view, further details the multi-function piston of FIG. 6,
9 showing piston oil outlet ports (308b) and the piston oil outlet channels (602).

10 Referring to FIG. 9, the key part to the third preferred mode is displayed. This is
11 the "pop top piston" system and this mode provides the most effective means of keeping
12 fuel and lubricant separated in that it allows no overlap whatsoever in the lubrication
13 and aspiration systems. FIG. 9 illustrates the entire system for one cylinder, clearly
14 showing the relationships of the "pop-top" piston system components, to include the
15 control peg (902b).

16 This system includes a piston (950), air or air/fuel ports (906), a piston rod (911),
17 piston oil supply port (907), piston oil return port (908), air or air fuel intake valve head
18 (900), valve seat (901), valve stem (902), valve spring (903), valve spring collar (903a),
19 valve guide (904). The system also includes a valve rod (902a) and a control peg
20 (902b).

21 Detailed is a multi-function piston configured for the third preferred mode. In this
22 mode, an air or air/fuel mixture intake valve head (900) and intake ports (905) are
23 actually located each the piston head. By substituting these valves and ports fixed

1 intake ports in the cylinder side-wall (103a), increased control over air/fuel aspiration
2 becomes possible. In this figure, the piston intake valve head (900) is open. Note that
3 the valve stem (902) extends into the piston head and the valve head (900) fits snugly
4 in the seats in the piston head valve seat (901).

5 The intake valve head (900) is pushed open by a valve rod (902a) one end of
6 which is attached to a stem (902) of the given valve (900) and the other end of which
7 impinges upon a control peg (902b) that prevents the valve rod (902a) from traveling
8 with the piston rod (911) for its full stroke. When the piston (950) and piston rod (911)
9 begin their power stroke, the valve rod (902a) travels with them, pushed along by the
10 valve stem (902), the inertia of the valve rod (902a) being overcome by the valve spring
11 (903).

12 Before the piston rod (911) completes its power stroke, valve rod (902a) comes
13 in contact with a control peg (902b). This control peg stops further travel of the valve
14 rod (902a). Although the valve rod stops moving, the piston rod (911) continues
15 traveling to the bottom of its power stroke, sliding past the now motionless valve rod
16 (902a). As a result, one end of the now motionless valve rod pushes against the valve
17 stem (902), compressing the valve spring (903) and forcing the valve head (900) open.
18 Air or air/fuel mixture rushes through the opened valve, transiting through air or air/fuel
19 ports (906) in the piston. Shortly thereafter, the piston rod (912) "bottoms out" finishing
20 its power stroke, and reverses direction to start its compression stroke.

21 As the piston rod (911) begins its compression stroke, its motion slides the valve
22 rod (902a) away from the control peg (902b) and allows the valve spring (903) to once
23 again force the valve head (900) closed. As the piston (950) continues in its

1 compression stroke, pressure above it in the combustion chamber further serves to
2 keep the valve head (900) firmly seated and closed. The piston stroke continues
3 through compression, combustion and exhaust and the cycle repeats.

4 Lubrication for each piston is accomplished through the dynamic pressure
5 lubrication oil system previously described, with oil distribution accomplished via a
6 piston oil supply port (907) and a piston oil return port (908). (Details of the lubrication
7 system are not illustrated in order to preserve simplicity, but are essentially identical to
8 the dynamic pressure system previously described.)

9 This mode provides increased control over the combustion process in that it
10 allows independent control of the cylinder head exhaust valve and off the air or air/fuel
11 intake valve. This control translates into cleaner, more efficient combustion and
12 increased adaptability to a wide range of fuels. Although this mode offers significant
13 performance benefits, it is also more complex to manufacture and maintain than the first
14 and second preferred modes.

15 FIG 10 provides increased detail as to how the various parts of the "pop-top"
16 piston relate and function. In this drawing the valve rod (902a), co-axial to the piston
17 rod (911), is pressing against valve stem (902), compressing the valve spring (903) via
18 the valve spring collar (903a) and forcing the valve head (900) open. The valve stem is
19 held in place by a valve guide (904). The piston is lubricated by oil emitting from the
20 piston oil supply port (1006).

21 The piston is centered in its cylinder by the oil hoarding rings (1008) that also
22 keep the lubrication oil from escaping above or below the piston. When the valve head
23 (900) opens, air or fuel/ail mixture rushes up from the base of the piston (1010) through

1 the air or air/fuel valve ports (905) past the valve seat (901) and out through the piston
2 head (1009).

3 FIG. 11 displays the "pop-top" piston system viewing the opposite side from FIG.
4 10 so that the piston oil return port (1107) is visible. Oil is forced through this port by
5 static pressure of additional oil pumped to the piston. The oil enters this port and
6 returns to the engine sump/crankcase. In this illustration, the valve head (900) is
7 closed, showing the valve spring (903) uncompressed in its resting position.

8 FIG. 12 provides an end view of the piston air or air/fuel ports (905), and of the
9 piston oil supply channels (1206) and return channels (1207), that feed oil to and from
10 the piston oil supply ports (1006) and piston oil return ports (1007), also feeding oil in
11 minute quantities to lubricate the valve stem in the center of the piston. The
12 relationships of the valve seat (901), valve stem (902), and valve guide (904) and the air
13 or air/fuel valve ports (905) to the rest of the piston are defined.

14 In FIG. 12a, viewing the center section of FIG. 12 in further detail, note that
15 opposite the bases of the piston oil supply (1206) and piston oil return (1207) channels,
16 and extending from the sump oil pick-up pipe (1201) and from the sump oil return outlet
17 pipe (1202), there are valve stem pinholes (1203) leading through the valve guide (904)
18 to the valve stem (902), centered in the piston rod (911), via which minute quantities of
19 oil may pass in order to lubricate the valve stem (902)

20 FIG. 13 shows the engine configured to operate with only one cylinder and
21 piston. Particularly singled out are the reciprocating power shaft (1301) that moves only
22 in a linear "in and out" manner and the single, unpaired magneto pick-up (1302).

1 In addition to the features documented in these drawings, further benefits may be
2 derived by incorporating different means of ignition, to include not only spark plugs, but,
3 alternatively, glow plugs and/or explosive compression in the combustion chamber.

4 Additionally, alternate incorporation of various drive trains, substituting, for
5 example, a rack and pinion, ratchet drive, or uni-directional or segmented gear
6 arrangement in place of the crank plate system here described, may render the system
7 lighter and more compact and may allow greater flexibility in choice of fuels by providing
8 for a greater range of piston dwell times than in rotary transmission systems, thus
9 promoting more complete and efficient fuel combustion. The engine may also
10 significantly benefit from addition of an oil cooler and from a turbo-charger, super-
11 charger, intake air compressor, fan, or blower. While the invention has been described
12 in connection with preferred embodiments, it is not intended to limit the scope of the
13 invention to the particular forms set forth, but on the contrary, it is intended to cover
14 such alternatives, modifications, and equivalents as may be included within the spirit
15 and scope of the invention as defined by the appended claims.